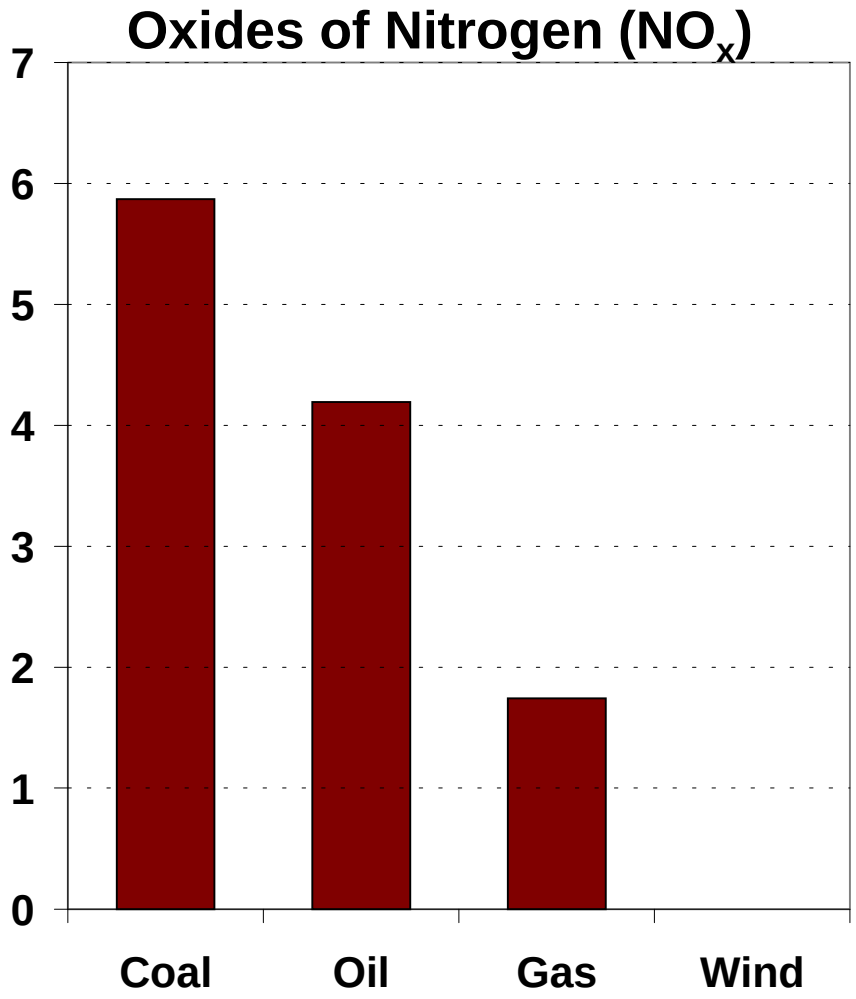
Quantification Efforts: Assigning emission reductions from energy savings or renewables

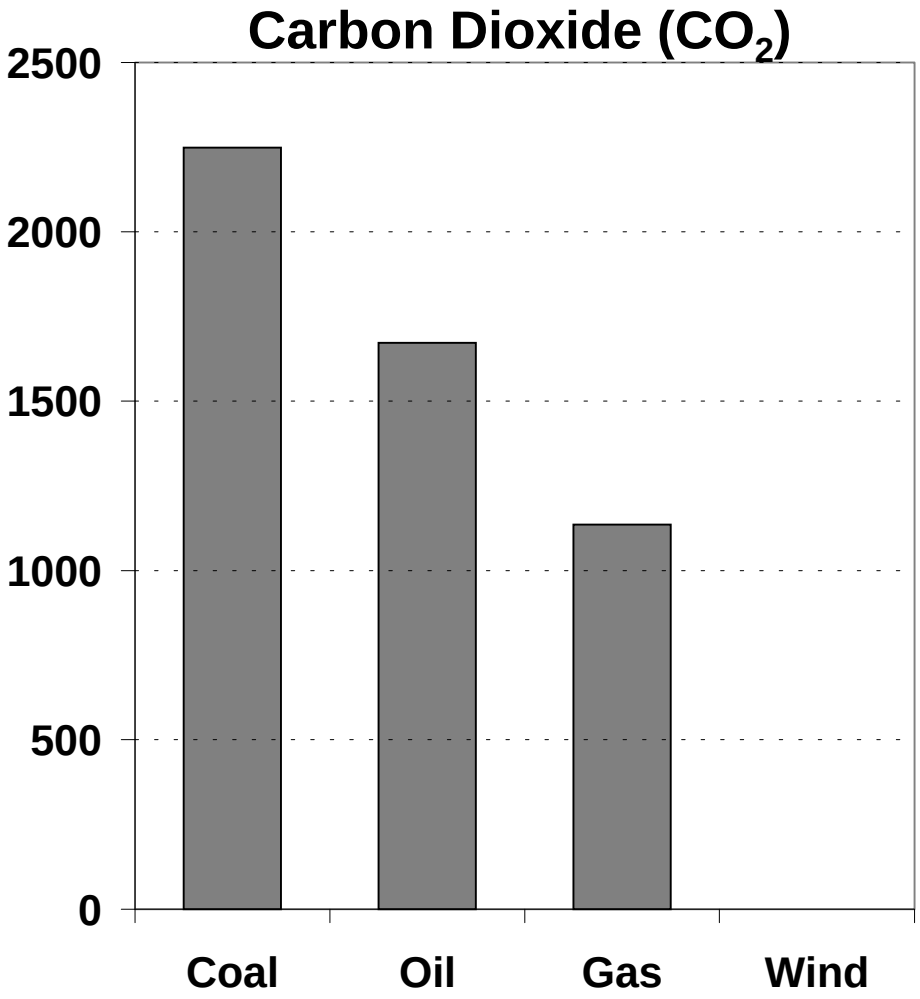
Art Diem, USEPA
(202)564-3525
diem.art@epa.gov
02-07-2003

Big Picture

- Energy Efficiency and Renewables have a great potential to reduce emissions from electricity generation:
  - Air Pollution
  - Greenhouse Gas Emissions

Emission Rates:
Fossil vs. Wind (lb/MWh), 1998





Data Source: E-GRID2000 v2.0

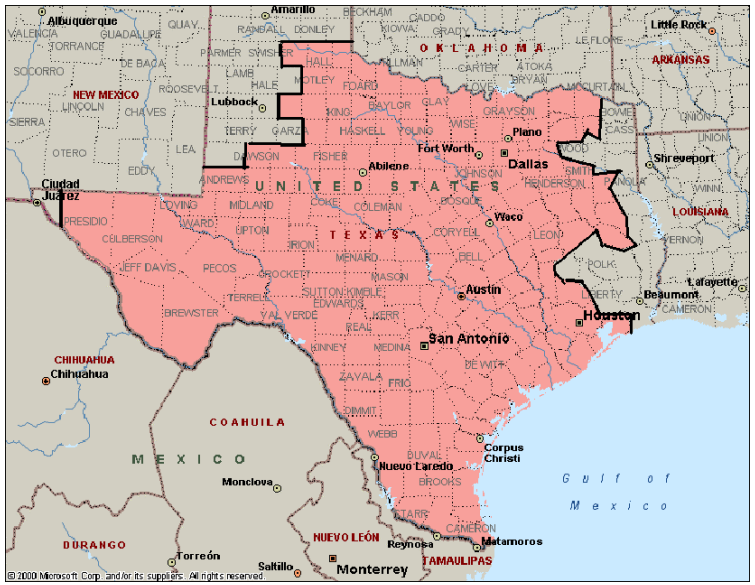
Prepared 11/04/2002 by Art Diem USEPA 202-564-3525

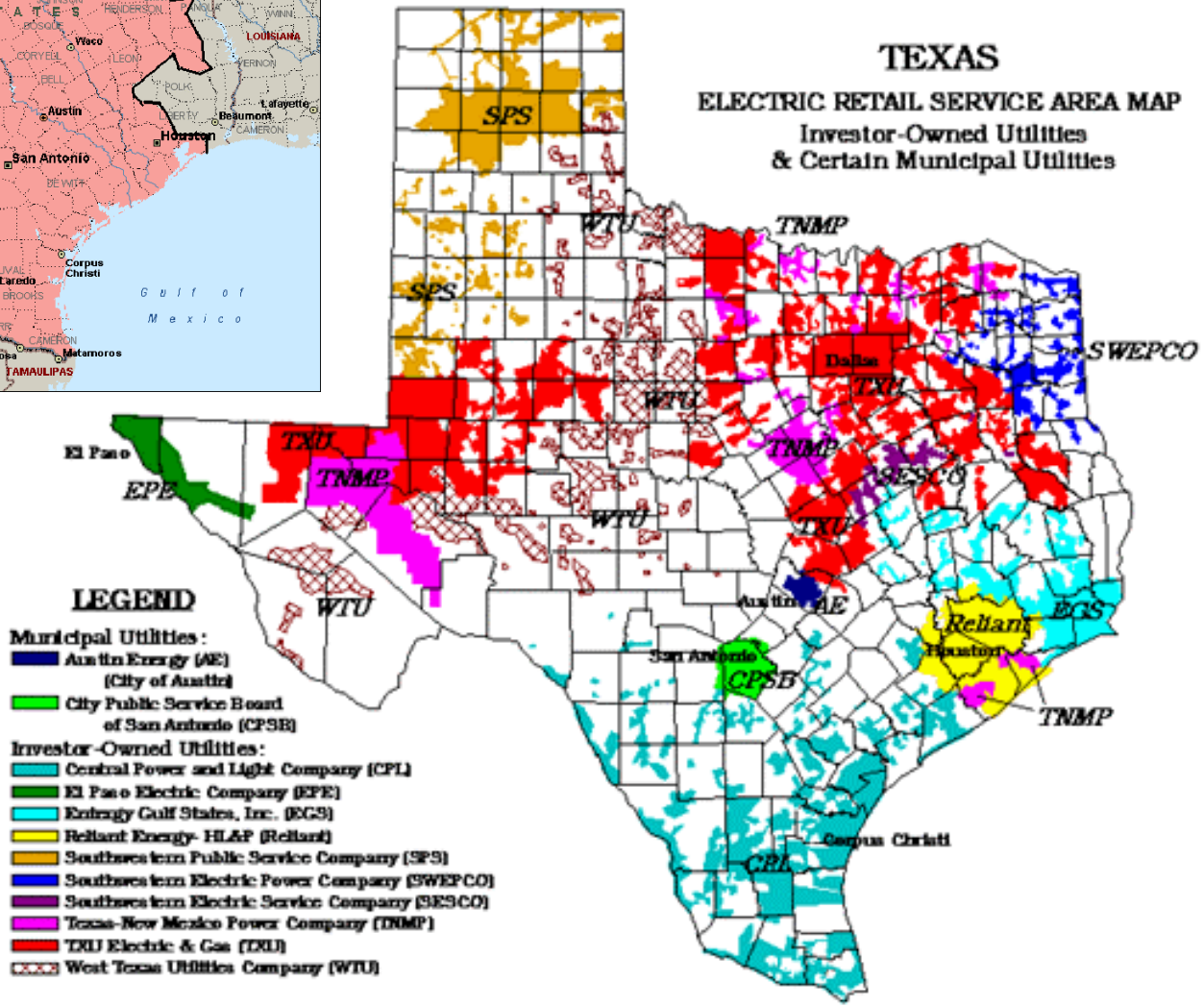
Texas Quantification Example

- Simplified quantification methodology
  - Converts energy savings (kWh) implemented into emission reductions (NOx SO2 CO2)
  - In: power control area specific energy savings
  - Out: county specific emission reductions
- Used in proposed Dallas SIP for S.B. 5 & 7 measures (to be adopted March 5, 2003)
- Based on E-GRID plant data and power control area interchange data (not a forecast model)
- Next steps, update information based on new EGRID data and minor method refinements

Why Estimating Reductions in TX (ERCOT) is relatively easy

ERCOT


Albuquerque
Amarillo
Little Rock
OKLAHOMA
ARKANSAS
NEW MEXICO
Lubbock
Plano
Fort Worth
Dallas
Shreveport
Abilene
Ciudad Juárez
UNITED STATES
Waco
LOUISIANA
TEXAS
Austin
Lafayette
Beaumont
Houston
San Antonio
CHIHUAHUA
Chihuahua
COAHUILA
MEXICO
Corpus Christi
Nuevo Laredo
Monclova
Gulf of Mexico
DURANGO
NUEVO LEÓN
Reynosa
Matamoros
Torreón
Saltillo
Monterrey
TAMAULIPAS
© 2000 Microsoft Corp. and/or its suppliers. All rights reserved.

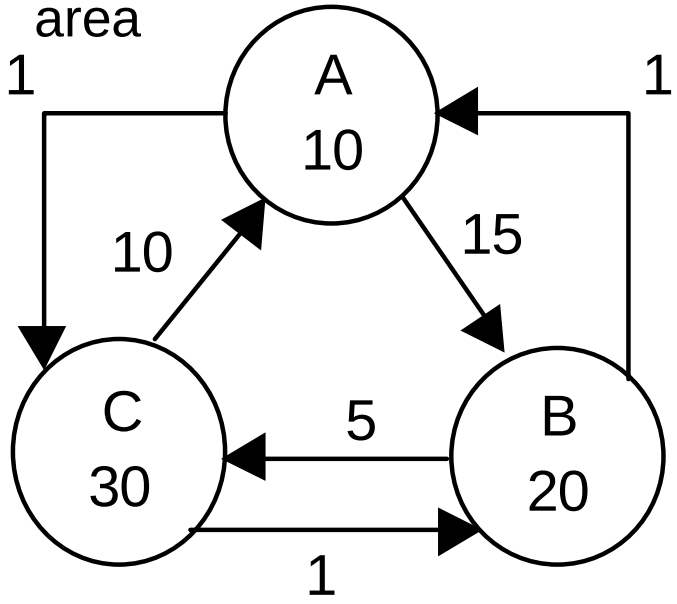

TEXAS
ELECTRIC RETAIL SERVICE AREA MAP
Investor-Owned Utilities
& Certain Municipal Utilities
SPS
WTU
TNMP
SWEPCO
Dallas
TXU
SESCO
El Paso
EPE
Austin
AE
Reliant
EGS
Houston
San Antonio
CPSB
Corpus Christi
CPL
LEGEND
Municipal Utilities:
Austin Energy (AE)
(City of Austin)
City Public Service Board
of San Antonio (CPSB)
Investor-Owned Utilities:
Central Power and Light Company (CPL)
El Paso Electric Company (EPE)
Entergy Gulf States, Inc. (EGS)
Reliant Energy- HL&P (Reliant)
Southwestern Public Service Company (SPS)
Southwestern Electric Power Company (SWEPCO)
Southwestern Electric Service Company (SESCO)
Texas-New Mexico Power Company (TNMP)
TXU Electric & Gas (TXU)
West Texas Utilities Company (WTU)

ERCOT Method Detail

- Step 1: Figure how much generation would be affected in each territory for energy savings that takes place in a specific territory
- Step 2: Figure how much generation at each plant could be affected by the demand reduction and proportion within PCA
- Step 3: Combine results from steps 1 and 2 and apply plant specific emission factors
- Step 4: Cumulate emission reductions to county level

Method Highlight: Power Control Area Information

- Using Matrix Algebra, Power Control Area Generation and Interchange Data are combined into simultaneous equations to determine how much of each power control area's generation ends up in each power control area




```
10A =  21a + -1b + -10c
20B = -15a + 36b +  -1c
30C =  -1a + -5b +  36c
(solve for a, b, & c)
```

```
K = x [M]
x = K [M-1]
```

$$\begin{bmatrix} 10A \\ 20B \\ 30C \end{bmatrix} = \begin{bmatrix} a \\ b \\ c \end{bmatrix} \times \begin{bmatrix} 21 & -1 & -10 \\ -15 & 36 & -1 \\ -1 & -5 & 36 \end{bmatrix}$$

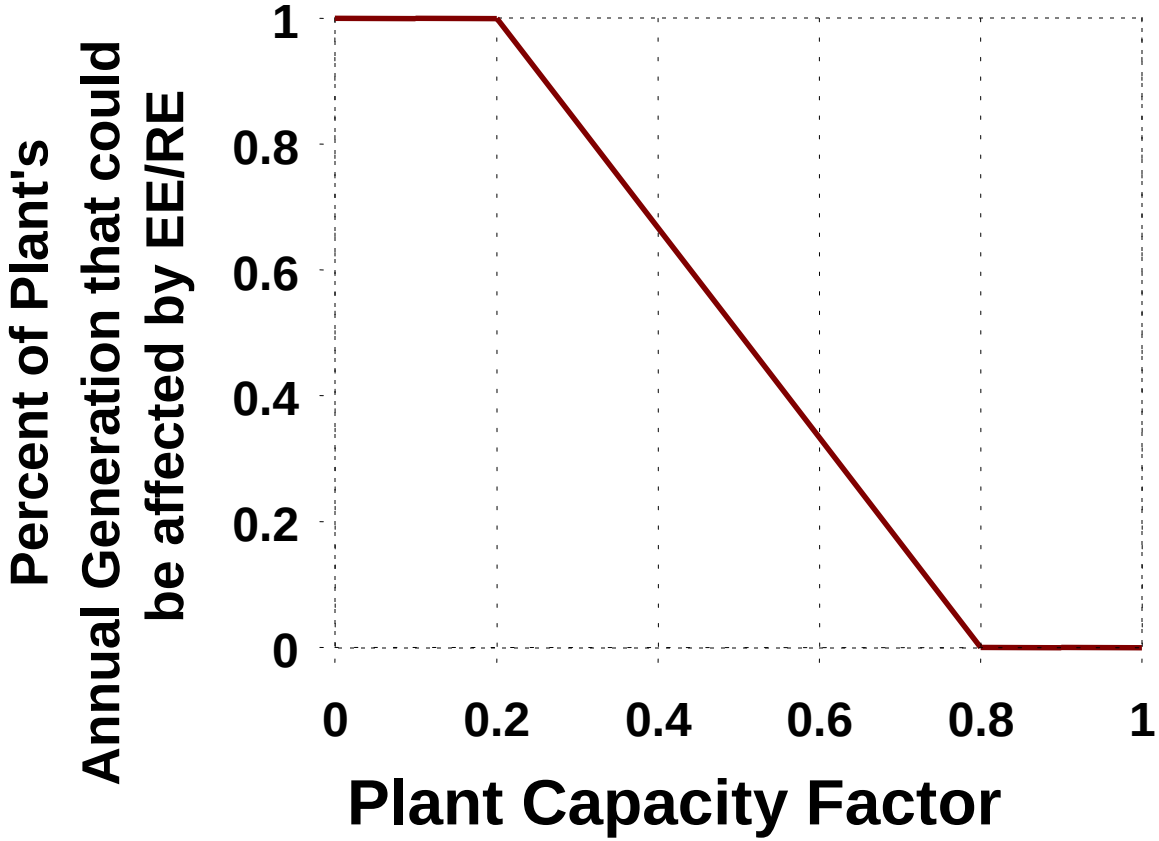
$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 10A \\ 20B \\ 30C \end{bmatrix} \times \begin{bmatrix} \\ \textit{inverse matrix} \\ \\ \end{bmatrix}$$

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 10A \\ 20B \\ 30C \end{bmatrix} \times \begin{bmatrix} 0.0507 & 0.0034 & 0.0142 \\ 0.0212 & 0.0293 & 0.0067 \\ 0.0044 & 0.0042 & 0.0291 \end{bmatrix}$$

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 0.507A & 0.068B & 0.425C \\ 0.212A & 0.586B & 0.201C \\ 0.044A & 0.083B & 0.873C \end{bmatrix}$$

Method Highlight: Plant Information

- Nuclear and Hydropower units are considered “baseload” units and are assumed to not be affected by EE/RE
- The amount of generation at each combustion-based plant that could be affected by EE/RE is estimated based on capacity factor.



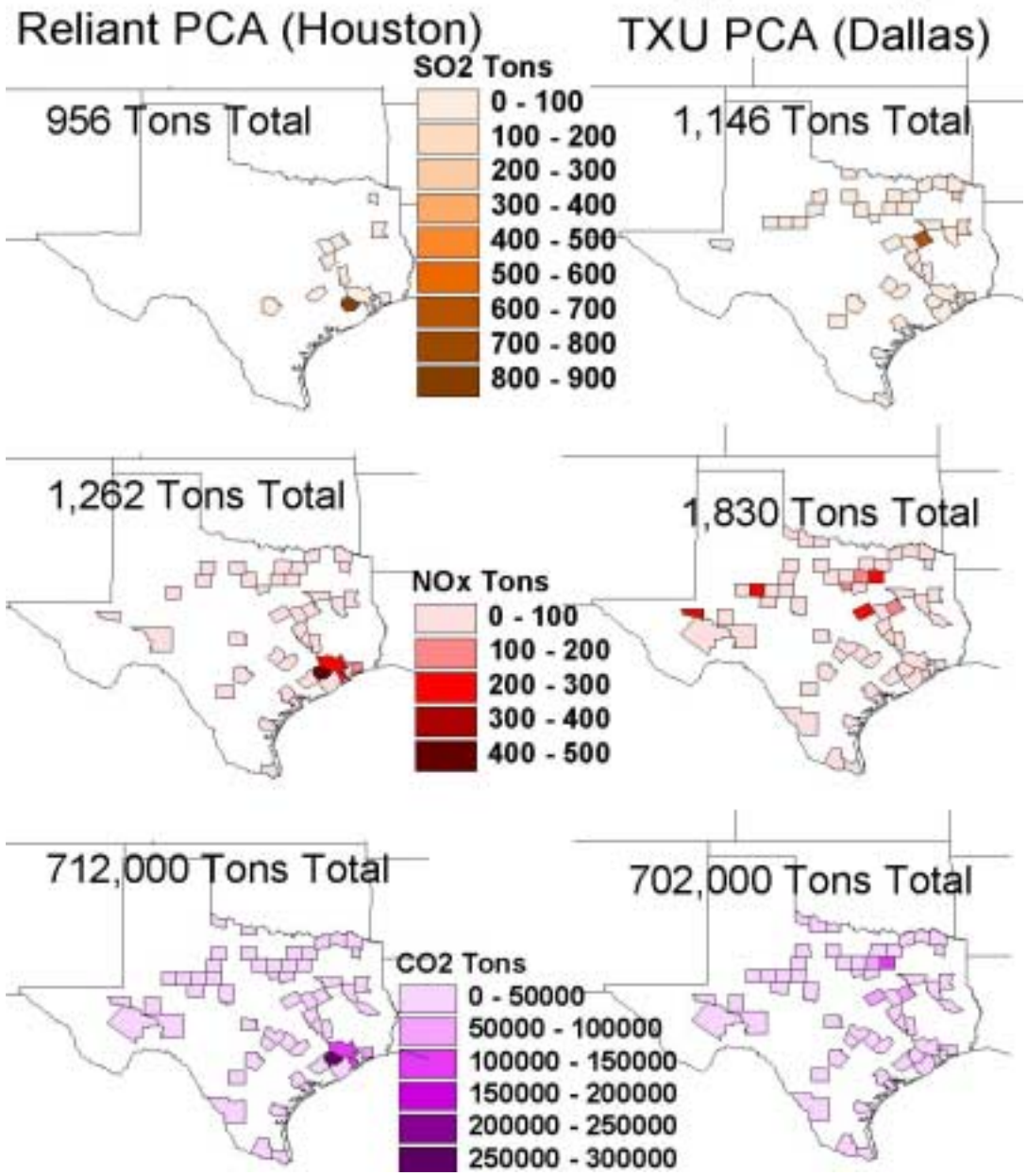
ERCOT Summary Results

(#/MWh of EE)	NOx	SO2	CO2
AEP West (ERCOT)	2.91	0.56	1,326
Austin Energy	2.57	2.09	1,488
Brownsville PUB	2.24	0.42	1,021
Lower Colorado River	3.16	3.23	1,772
Reliant	2.52	1.91	1,423

ERCOT Summary Results

(#/MWh of EE)	NOx	SO2	CO2
San Antonio PS	2.66	1.85	1,489
South Texas Electric Coop.	3.29	0.69	1,487
Texas Municipal Power Pool	3.22	1.74	1,434
Texas-New Mexico Power	1.59	1.80	1,404
TXU Electric	3.66	2.29	1,404

Emission Reductions by County for 1 million MWh energy savings



TX Approach: Pros and Cons

- PROs
  - Simple
    - does not rely on dispatch modeling (less complicated, less expensive)
  - Uses actual data
    - plant generation, imports and exports between power control areas, capacity factor and emission data (can account for predicted changes in generation fleet in the future)
  - Locational component to emission reductions
    - Distributes estimated emission reductions to specific locations
- CONs
  - Not as precise as a method based on dispatch or forecasting modeling:
    - may overestimate reductions at plants that were not running for reasons other than dispatch (capacity factor surrogate).
  - Interchange Data is has not been through a rigorous QA/QC process
  - Results based on annual data
    - no consideration of season or load shape of electricity reductions
  - Transmission constraints
    - considered only to the extent that they affect interchange data.

TX Example Conclusions

- Converting energy savings into emission reductions (how much & location) can be done in a reasonable way
- Innovative and simplified methods can work
- Consideration of Cap and Trade Programs is important

Other quantification efforts

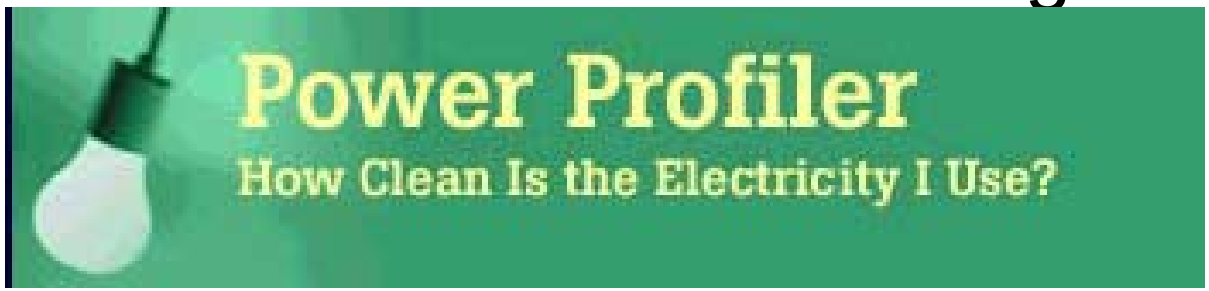
- Western Regional Air Partnership
  - IPM Modeling under the Regional Haze SIP (Section 309 Renewable Energy requirements)
  - http://wrapair.org/forums/IOC/
- OTC Workbook
  - Based on PROSYM Model
  - http://www.sso.org/otc/Publications/pub2.htm
- Others ...

Quantification Issues important to Region 3?

- Accounting for Cap and Trade Programs
- Energy Imports and Exports
- Regional approach to quantification?
- New data sources?
  - PJM Generation Attribute Tracking System
    - designed to support environmental disclosure and renewable portfolio standards in PJM, but may contain useful information for other quantification efforts

Plugs

- Year 2000 EGRID Data Available:
  - http://www.epa.gov/airmarkets/egrid/
- Online Power Profiler coming soon



  - http:www.epa.gov/cleanenergy

- Please contact Art Diem (202)564-3525 for more information on quantification efforts